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# Effects of an Oil Spill on American Lobster (Homarus americanus) from Placentia Bay, Newfoundland

U. P. Williams, J. W. Kiceniuk,
J. E. Ryder, and J. R. Botta

Science Branch
Department of Fisheries and Oceans
P.O. Box 5667
St. John's, Newfoundland A1C 5X1

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# EFFECTS OF AN OIL SPILL ON AMERICAN LOBSTER (HOMARUS AMERICANUS) FROM PLACENTIA BAY, NEWFOUNDLAND

by

U.P. Williams[1], J.W. Kiceniuk[1], J.E. Ryder[1], and J.R. Botta[2]

1 Science Branch

Department of Fisheries and Oceans

P.O. Box 5667

St. John's, Newfoundland A1C 5X1

2 Inspection Services Branch

Department of Fisheries and Oceans

P.O. Box 5667

St. John's, Newfoundland A1C 5X1

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## ABSTRACT

Williams, U.P., J.W. Kiceniuk, J.E. Ryder, and J.R. Botta. 1988. Effects of an oil spill on American lobster (Homarus americanus) from Placentia Bay, Newfoundland. Can. Tech. Rep. Fish. Aquat. Sci. 1650: iv + 9 p.

In March 1988 an accidental spill of crude oil occurred at the wharf of the Come by Chance oil refinery, Placentia Bay, Newfoundland. Approximately 500 barrels of light crude oil were spilled during offloading of a tanker. Concern was expressed by local fishermen as to the effect of the spill on the lobster fishery in the Bay. Studies of selected parameters were undertaken to determine the possible short and long term effects on the local lobster fishery. Sensory analyses were carried out to ascertain the effects of the oil on the taste and odor of lobster. Lobster muscle and hepatopancreas were analyzed for PAH (polycyclic aromatic hydrocarbon) content and levels of gill browning were determined. Sediments were sampled at various locations in the Bay and levels of PAHs were determined in an attempt to delineate the extent of contamination. Results from the sensory analyses indicate that there was no tainting of lobster samples obtained from the Come by Chance area. There was also no evidence of gill browning or of elevated levels of PAHs in either tail muscle or hepatopancreas. Elevated levels of PAH were not detected in any of the sediments from the Bay. The results indicate that lobster were not contaminated as a result of the oil spill. Based on the results of analyses of sediments for PAHs, future contamination, as a result of the spill at the oil refinery wharf, is not anticipated.



## RÉSUMÉ

Williams, U.P., J.W. Kiceniuk, J.E. Ryder, and J.R. Botta. 1988. Effects of an oil spill on American lobster (Homarus americanus) from Placentia Bay, Newfoundland. Can. Tech. Rep. Fish. Aquat. Sci. 1650: iv + 9 p.

En mars 1988, du pétrole brut a été déversé accidentellement au quai de la raffinerie de pétrole Come by Chance de la baie Placentia (Terre-Neuve). Environ 5 000 barils de pétrole brut léger ont été déversés lors du déchargement d'un pétrolier. Les pêcheurs locaux s'inquiétaient de l'effet du déversement sur la pêche au homard dans la baie. Des études portant sur des paramètres choisis ont été entreprises afin de déterminer les effets possibles à court et à long terme sur la pêche locale au homard. Des analyses sensorielles ont été effectuées afin d'évaluer les effets du pétrole sur le goût et l'odeur du homard. On a mesuré la teneur de HAP (hydrocarbure aromatique polycyclique) dans les muscles et l'hépatopancréas du homard et déterminé le degré de brunissement des branchies. Des échantillons de sédiments ont été prélevés à divers endroits dans la baie et on a mesuré la teneur en HAP en vue de déterminer l'étendue de la contamination. Les résultats des analyses sensorielles montrent que les échantillons de homard provenant de la région Come by Chance n'étaient pas infectés. On n'a pas relevé non plus de brunissement des branchies ou de teneurs élevées en HAP dans le muscle de la queue ou dans l'hépatopancréas. Des teneur élevées in HAP n'ont pas été relevées dans aucun échantillon de sédiment de la baie. Les résultats montrent que les homards n'étaien' pas contaminés pa suite du déversement de pétrole. D'après les résultats des analyses pour la recherche de HPA dans les sédiments, on ne prévoit pas de contamination dans l'avenir attribuable au déversement qui s'est produit au quai de la raffinerie.

## INTRODUCTION

Accidental spills of oil into the nearshore environment have been fairly numerous (Gullicksen and Taassen 1982; Williams et al. 1985; Conan 1982; Hall et.al. 1982; Sanders et al. 1980; Kiceniuk and Williams 1987) and such spills can engender concern about possible damage to local fisheries. Aromatic hydrocarbons are an important constituent of oil and are of special concern as they can be bioaccumulated in shellfish (Lee et al. 1976; Dunn and Fee 1979; Uthe et al. 1984; Williams et al. 1985.).

In March 1988 an accidental spill of crude oil occurred at the wharf of the oil refinery at Come by Chance, Newfoundland. Approximately 500 barrels of a light crude oil were spilled during offloading of a tanker. Concern was expressed by local fishermen regarding the possible short and long term impact of the spill on the lobster fishery in Placentia Bay.

Studies of selected parameters were initiated to determine if lobster and/or lobster habitat were affected. Taste panels were conducted to ascertain the effects of the oil on the taste and odor of the lobster. Levels of gill browning were determined and lobster hepatopancreas and tail muscle were analyzed for PAH content. A sediment survey was undertaken and PAH concentration measured in an attempt to delineate the extent of contamination, if any, in the sediment.

## METHODS

### SAMPLING

Lobsters were caught using divers and lobster pots immediately following the spill of crude oil in March 1988. Lobsters were taken from the area of the oil refinery as well as from Bay l'Argent, Fortune Bay. The latter site served as the control site. Sampling was conducted between March 23 and March 27, 1988.

### GILL BROWNING

The extent of gill browning was determined by the removal of the right side of the carapace and examination of the gills for any evidence of brown spots or areas. The level of browning was calculated in terms of percentage of the gill.

### PAH EXTRACTION & ANALYSES

Analyses were conducted on lobster tail and hepatopancreas samples from Come by Chance and Bay l'Argent, Fortune Bay. Extraction and analyses of the tissue for polycyclic aromatic hydrocarbons was carried out as per Williams et al (1985) with the exception that each sample was filtered through a 0.5 $\mu$m Millex SR PTFE filter prior to analysis by LC.

A sediment survey was conducted of Placentia Bay (May 2-4, 1988) and extraction, identification and quantitation of aromatic hydrocarbons (AH) conducted as per Kiceniuk and Williams (1987). Sediment samples were also taken by divers during the sampling of the lobsters in March 1988.

### TASTE PANEL SAMPLE PREPARATION

After the gill browning analyses were completed the lobsters were immediately immersed in 7.3 liters of boiling tap water (containing 50 g salt) and the samples were boiled for 15 minutes. Timing did not commence until the water containing the lobsters began to boil. Untreated lobster were never cooked in a pot used to cook treated samples. Once the samples were cooked, one half (lengthwise section) of the tail meat was immediately used for sensory evaluation. The other piece was stored at -80 degrees Celius until analyzed for PAH content.

The portion of tail meat used for sensory analyses was subdivided, crosswise, into sections and were individually placed in different labelled glass petri dishes. These were then served hot using an electric warming tray. All petri dishes were labelled using three digit random numbers. All samples were presented in a order described by Stone and Sidel (1985) with the exception that panelists were not given replicate samples. During all evaluations care was taken to ensure that, during any one session, all samples evaluated by any particular panelist were from identical anatomical sections of the tail.

### TASTE PANELS

Two different types of taste panels and an odor discrimination panel were conducted on the lobster samples from both the oiled and the control site. In the case of the odor discrimination testing two uncooked lobsters from Placentia Bay were placed inside each of four different one-gallon closed containers and two uncooked lobsters from Fortune Bay were placed inside each of another four different one-gallon closed containers. Each container was identified using a three digit random number. The odor of the uncooked lobster was evaluated by 10 panelists experienced in discrimination testing. Each panelist evaluated the samples (two containers containing lobster from Placentia Bay and one container from Fortune Bay or two containers containing lobsters from Fortune Bay and one container containing lobster from Placentia Bay) using the triangle test (Fig. 1) as described by Stone and Sidel (1985). All lobsters were then cooked and evaluated by the same panelists using the triangle test (Fig. 2). The following day the above procedure was repeated. Thus 20 panelists evaluated the difference in odor and 20 panelists evaluated the difference in sensory quality of cooked lobster. Prior to conducting the discrimination testing of the uncooked lobster a paired preference test was conducted using 20 different panelists (10 panelists on each of 2 different days) who were not experienced with discrimination testing. The paired preference test (Fig. 3) included a no-preference choice for the subject (Stone and Sidel 1985). Regardless of the type of panel, panelists were not informed of how the samples had been treated. Evaluations were conducted in individually partitioned booths, using daylight fluorescent lighting. The

panelists used room temperature tap water for rinsing their mouths between samples. In general, samples were evaluated within 15 minutes of being prepared.

STASTICAL ANALYSES

The results of the sensory evaluations were statistically analyzed by comparing the observed frequency of preference and correct identifications to tabulated frequencies regarding the two tailed preference test and triangle test, respectively, (Stone and Sidel 1985).

The results of the polycyclic aromatic hydrocarbon analyses were statistically analyzed by one way analyses of variance on ranked data after determining that the data lacked normal distribution.

## RESULTS

There was no evidence of gill browning in any of the samples from either the Baie l'Argent or Come by Chance sites. The odor of raw lobster from Placentia Bay did not significantly differ from the odor of raw lobster from Fortune Bay (Table 1). The sensory quality of cooked lobster tail from Placentia did not significantly differ from the sensory quality of cooked lobster from Fortune Bay (Tables 2 and 3). Statistical analyses of the PAH results from the tissue extractions revealed that there is no significant difference in PAH levels between sites (Tables 4 and 5). There was also no significant difference in PAH sediment concentrations between Placentia and Fortune Bays (Table 6).

## DISCUSSION

The purpose of the study was to determine the short and long term effects of the spill of crude oil into a lobster fishing area. The problem was to determine if any fraction of the oil was incorporated into lobster tissue or bottom sediments.

Incorporation of hydrocarbons into lobster tissue gives rise to two major concerns, namely, the incorporation of polycyclic aromatic hydrocarbons into tissues and the possibility of tainting. Elevated levels of oil in sediments gives rise to the possibility of the sediments acting as a potential source of hydrocarbons over time.

Tainting is defined as as "the development of a flavour or odor in the organism which, when caught or harvested, is not typical of the flavour or odor of the organisms themselves" (GESAMP 1982). Tainting can arise either from improper handling of a product or from exposure of the living organism to a contaminant. Tainting of a resource or the mere perception of tainting, can result in the closure of an area to fishing which could result in severe financial losses to fishermen.

In the sensory analyses component of this study both odor and taste testing were carried out to ascertain if lobster were tainted following exposure. Williams et al. (1988) in a study of the effects of diesel oil on lobster odor and taste, found that the odor of the raw lobster was a more sensitive indicator of taint than was the taste test of cooked lobster. In the present study, the panelists detected no difference in odor of the raw lobster between those sampled at the oiled and control sites. This fact was supported by the finding that there was also no difference in taste between those sampled at the two sites nor was lobster from one site preferred over lobster from the other site.

There is considerable evidence to indicate that lobsters and other shellfish have the ability to accumulate and bioconcentrate polycyclic aromatic hydrocarbons (PAH)s in their tissue (McLeese et al. 1983; Lee et al. 1976; James and Little 1984; Uthe and Muscial 1986). Polycyclic aromatic hydrocarbons are of special concern as certain PAHs such as benzo[a]pyrene which may be found at trace levels in petroleum and wood, coal and oil soot, are carcinogenic (Dunn and Fee 1979). Also, detoxification enzyme levels in shellfish, including lobster, are lower than in finfish and are refractory to induction, suggesting longer metabolism and depuration rates (Payne 1977; Payne and May 1979). Upon examination of the PAH data for both the hepatopancreas (Table 4) and the tail muscle (Table 5), it is obvious that there is no difference between the control and the spill site (Tables 4 and 5). Given that elevated levels of PAHs were not found in the tissue and that the sensory analyses revealed no tainting, it may reasonably be assumed that the oil spill had no direct short term effect on lobster from the area.

The potential for a long term effect of this oil spill on lobster from Come by Chance, could only exist if oil was trapped within the sediments. If this was the case, oil would be bioavailable to lobster. Kiceniuk and Williams (1987) reported that oil trapped within sediments can be present for a number of years following the initial spill. Oil that is trapped within sediments could act as a long term source of PAHs to bottom dwellers such as flounder and lobster. The sediment survey conducted in Placentia Bay and subsequent analyses of the sediment for PAH (Table 6, Fig. 1) revealed that PAH levels were not elevated in the sediment at the spill site. As a result oil would not be available to the lobsters over time and no long term impact on lobsters would be anticipated.

It has been previously demonstrated that extensive gill browning can occur in lobsters exposed to petroleum hydrocarbons (Payne et al. 1983) and it has been postulated that gill browning may reflect a process of cell debilitation which is enhanced under conditions of stress such as exposure to oil (Payne et al. 1983). Because no gill browning was observed, it may be assumed that the lobsters were not under sufficient stress from exposure to oil, to cause this effect to occur.

In conclusion, studies of these selected parameters indicate that the oil spill at Come by Chance had no short term effect on lobster and, since no contamination remained in the sediments,

long term effects are unlikely. An earlier laboratory study in which lobster were chronically exposed to petroleum for a prolonged period of time (6 months) supports this conclusion (Payne et al. 1983).

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Table 1. Effect of water adjacent to Come-by-Chance (Placentia Bay) on the odor of raw whole lobster, assessed using the triangle test.*

| Number of correct identifications | Number of incorrect identifications |
|---|---|
| 6 ns[b] | 14 |

* Lobster from Placentia Bay were compared to lobster from Fortune Bay. The lobster were caught between March 23 and March 27, 1988.

b ($p=0.703$)

Table 2. Effect of water adjacent to Come-by-Chance (Placentia Bay) on the sensory quality of cooked lobster (tail section) assessed using the triangle test. **

| Number of correct identifications | Number of incorrect identifications |
|---|---|
| 5 ns[b] | 15 |

* Lobster from Placentia Bay were compared to lobster from Fortune Bay. The lobster were caught between March 23 and March 27, 1988.

b ($p=0.848$)

Table 3. Effect of water adjacent to Come-by-Chance (Placentia Bay) on the acceptability (preference) of cooked lobster (tail section) assessed using a paired preference test.

| Number of panelists that preferred lobster from Placentia Bay | Number of panelists that preferred Lobster from Fortune Bay | Number of panelists that indicated no preference. |
|---|---|---|
| 6 ns[a] | 7 | 7 |

a (In order to be significant 16 of 20 samples would have to be preferred).

Table 4. Lobster hepatopancreas PAH (µg PAH/g tissue)

| PAH | Baie l'Argent | Come by Chance | p value |
|---|---|---|---|
| Naphthalene | 0.4140 | 0.7364 | 0.9282 |
| Fluorene | 0.1090 | 0.4163 | 0.7146 |
| Phenanthrene | 0.4092 | 0.3190 | 0.6632 |
| Pyrene | 0.7153 | 0.4329 | 0.1483 |
| Benzo[a]pyrene | 0.2473 | 0.1401 | 0.6476 |

Table 5. Lobster tail muscle PAH (µg PAH/g tissue)

| PAH | Baie l'Argent | Come by Chance | p value |
|---|---|---|---|
| Naphthalene | 0.1670 | 0.0791 | 0.3301 |
| Fluorene | 0.0004 | 0.0034 | 0.7641 |
| Phenanthrene | 0.3335 | 0.2705 | 0.6711 |
| Pyrene | 0.3141 | 0.0311 | 0.6398 |
| Benzo[a]pyrene | 0.0213 | 0.0368 | 0.3075 |

Table 6. PAH concentrtion in sediment (µg PAH/g sediment)

| PAH | Baie l'Argent | Come by Chance | p value |
|---|---|---|---|
| Naphthalene | .0819 | .4967 | .4854 |
| Fluorene | .0000 | .0458 | .3277 |
| Phenanthrene | .1180 | .0818 | .6602 |
| Pyrene | .0000 | .0010 | .5706 |
| Benzo[a]pyrene | .0231 | .0086 | .4239 |

Fig. 1. Sensory evaluation form used to assess difference(s) between odor of raw lobster from Placentia Bay and odor of raw lobster from Fortune Bay.

NAME: _____

DATE: _____

PRODUCT: _____

In front of you are three coded samples, two are the same and one is different: Starting with _____, then _____, followed by _____ evaluate the samples and circle the code that is different from the other two. You may re-evaluate the samples; you must make a choice. Thank you.

_____ _____ _____

Fig. 2. Sensory evaluation form used to assess acceptability (preference) of sensory quality of lobster from Placentia Bay and of lobster from Fortune Bay.

NAME: _____

DATE: _____

PRODUCT: _____

In front of you are three coded samples, two are the same and one is different:Starting with _____, then _____, followed by _____ evaluate the odor of the samples and circle the code that is different from the other two. You may re-evaluate the samples; you must make a choice. Thank you.

_____ _____ _____

Fig. 3. Sensory evaluation form used to assess difference(s) between sensory quality of cooked lobster from Placentia Bay and sensory quality of cooked lobster from Fortune Bay.

NAME: _____

DATE: _____

PRODUCT: _____

Evaluate both products starting with _____. Check the box for the product you prefer. You must make a choice. Thank you.

_____

_____

Like both equally

Dislike both equally